probably strengthen rather than obliterate the weather curve, especially when we consider the effect of increasing vegetation which would follow increased rainfall. L. E. HICKS.

Lincoln, Neb., Nov. 4, 1892.

The Moon's Atmosphere.

IN *Science* of Feb. 24, Sir Robert Ball makes application of the kinetic theory of gases to explain the absence of air from the moon. He observes that, although the mean molecular velocity of translation is less than that required by a body projected vertically from the moon to overcome the moon's attraction, "in the course of their movements, individual molecules frequently attain velocities very much in excess of the average pace," and would therefore be able to escape from the moon into space, and thus, in time, the whole atmosphere would be lost. I think a full consideration of the subject will not justify that conclusion, but that we shall be obliged to resort to some other physical laws to solve this old problem of speculation.

The kinetic theory requires all the molecules of a gas to have equal masses, equal energies, and hence equal mean velocities. This mean velocity for the hydrogen molecules at 0° C. is about 1,800 metres per second, while that of oxygen and nitrogen is about 450 metres per second, since the velocity is inversely proportional to the square root of the mass of the molecule. To overcome the moon's attraction a body must have a vertical velocity of about 2,200 metres per second. But it must be remarked that the escaping molecules, if there are such, are only those of the outer confines of the atmospheric envelope, where the mean free path of the molecules is relatively very great, as suggested with respect to the earth's atmosphere by H. Daniells ("Principles of Physics"), and the temperature of those regions is very low. If the temperature is about 68° absolute scale (— 204° C.), as assumed by some authorities, the mean molecular velocity falls to about 225 metres a second, since the velocity varies as the square root of the absolute temperature. The vertical velocity, then, or the vertical component of the velocity must be about ten times the mean velocity to balance the force of gravitation, which is not probable.

Again, if the temperature is much lower than 68° absolute, approximating the absolute zero, and the molecular velocity always obeys the law before mentioned, the velocity also would approximate zero, and of course the molecules could not escape the attraction. It appears, then, to be largely a question of the temperature of the outer limits of an atmosphere. With this in view, let us compare results on planetary bodies of different size and stage of world life. As already suggested, with respect to the earth and moon, the earth's attraction at the surface is about five times that of the moon at its surface. This, *cœteris paribus*, would require about five times greater molecular velocity of its atmosphere to escape than for that of the moon. But, if we take into account the previous history of the two bodies, it is observed that the earth was highly heated for ages after the moon had become comparatively cool, and this must have rarefied and expelled its atmosphere to great heights, and maintained a temperature in those regions which, according to the proposition under discussion, would have caused the earth to lose its atmosphere. In general, it would follow that the major planets and larger satellites would lose their atmospheres more completely while cooling than the smaller ones, unless they have correspondingly greater quantities of volatile matter in their composition than the smaller ones. And such seems to be the result. Even Jupiter, whose attraction at the surface is 2.6 times that of the earth, is believed to have an atmosphere much less extensive proportionately than the earth. Mars offers a good example of a small planet with a copious atmosphere. Its attraction is only about twice that of the moon. Why has he not lost his atmosphere? If the application of the kinetic theory alone explains the loss of the moon's atmosphere, it would require Mars to have suffered the same fate before now. Possibly we are committing the error of the Greek philosophers in treating melecules as independent masses instead of regarding them as inter-dependent centres of activity whose phenomena, as a system, constitute the qualities of matter. I do not assume to offer a solution for this complex problem, but hope rather to encourage discussion which will call out all the principles of physical science applicable to it. W. H. HOWARD.

Adrian College, Adrian, Mich., April 15.

Note on the Crystalline Lens of the Eye.

MR. MCLOUTH'S observation upon "A Peculiar Eye," as observed by him in "a domestic animal," given in *Science*, No. 531, would have been considerably enhanced in value had he recorded at the same time what that "domestic animal" was; whether it was an anserine fowl, as a duck or goose; or a gallinaceous one, as a hen, turkey, peacock, or guinea-fowl; or whether a carnivorous mammal, as a dog, or a cat; or an *Equus*, or a *Bos*, or a *Sus*, or an *Ovis*, or what not.

To the minds of some, the so-called "domestic animals" form a natural group, and even such an authority as Girard was so blind as once to propose a *special* classification for the domesticated mammals! It is not uninteresting to trace the origin of this idea, associated as it is in a way with the kindred one of man holding a place apart from the rest of organized beings.

It is only necessary to invite Mr. McLouth's attention here to the fact that the crystalline lens in the eye of man consists of *three* triangular segments, and their existence is easily demonstrated by immersion of the lens in strong alcohol, or by boiling it. The apices of these three segments are at the centre of the lens, in *front;* their bases in the circumference. Another structural feature of the lens is seen in the laminæ of which it is composed. The treatment just proposed demonstrates these also, consisting, as they do, of concentric layers, which are firm at the centre, but become softer as we approach the peripheral ones. Likewise, by thus treating the crystalline lens from the eye of a horse, we prove that it also divides into its concentric laminæ, and its *three* triangular segments. But whether this holds true in the case of all vertebrates has not, I think, been demonstrated. Very likely the crystalline lens of the "domestic animal" examined by Mr. McLouth had been submitted to a process which had a similar effect upon it as boiling or immersion in alcohol would have had, and simply exhibited its normal structure. From what I can gather from the communication of your correspondent in *Science* there was nothing abnormal about the lens of the eye he examined.

R. W. SHUFELDT.

Takoma, D.C., April 14.

The Aurora.

IN *Science* for April 7, at page 186, certain statements of mine in regard to auroral effects proceeding from the sun's eastern limb are called in question. It would have been much more satisfactory if these criticisms had given evidence of such familiarity with the subject as would be shown by the mention of even a single date on which it might be claimed that an aurora appeared in the absence of well-defined solar conditions of the character indicated. Except where specific mention is made of such individual instances, the writer proposes to refrain from discussion, which would readily become interminable as well as utterly inconclusive. Such results as those of Professor Ricco, recently announced in *Astronomy and Astro-Physics* and elsewhere, it is a pleasure to meet with and comment upon. He simply takes the case of the great magnetic storms of 1892, which were eleven in number, and studies the coincident solar conditions, especially with reference to the location of spot groups at the meridian. In seven out of the eleven instances he finds that there were such groups on the meridian, but that the magnetic effect, if it proceeded from them at all, was not felt for a varying period of from twenty-one to fifty-one hours subsequently. If, however, he had gone further and inquired what there was at the eastern limb on these dates, he would have found that there was a spot group in that location in every one of these instances without any exception whatever, and that these groups were located upon areas which were much disturbed at successive returns by rotation. Moreover, there was in these instances no appreciable retardation or variability of retardation, the magnetic storm being in progress